The Mining Journal
AND COMMERCIAL GAZETTE.

SUPPLEMENT.

REVIEWS.

Geology and Mineralogy considered with reference to Natural Theology. By the Rev. WILLIAM BUCKLAND, D.D., Canon of Christ Church, and Reader in Geology and Mineralogy in the University of Oxford. 2 vols. Pickering. London, 1836.

The "Bridgewater Treatises," one of which is now before us, form one of the most interesting and valuable accessions to our scientific literature which the present age has produced.

The history of this series is curious, and highly honourable to the nobleman whose name is associated with it. We shall, therefore, briefly notice the circumstances from which it originated, although perhaps to many of our readers they are already well known. Francis Henry, Earl of Bridgewater, died in February, 1829, and left by his will the munificent bequest of 8000*l.*, to be expended in the production of a work "On the Power, Wisdom, and Goodness of God, as manifested in the Creation, illustrating such work by all reasonable arguments." The testator proceeds to enumerate such arguments as occurred to him, and directs the sum of 8000*l.* to be paid to the author or authors employed, who are also to receive the profits arising from the sale of the work. The executor of this bequest was to be, the then President of the Royal Society, and the duty thus devolved on Davies Gilbert, Esq., who preceded the Duke of Sussex in this office. In executing this important trust, Mr. Davies Gilbert requested the assistance of the Archbishop of Canterbury, the Bishop of London, and a relative of the deceased nobleman; and the result of their deliberations was to nominate eight gentlemen of high literary and scientific attainments, to produce eight separate works agreeably to the will of the testator, and following as nearly as possible the line of argument which he had suggested. Seven of these works have been published within the last three or four years, and the last of the series, Dr. Buckland's long expected treatise, is now before us.

The work consists of two volumes, the first containing the argument itself, the second a series of beautiful and elaborate plates, by which it is illustrated. The plates are accompanied by a copious and instructive letter-press description.

The qualifications of Dr. Buckland for the important trust reposed in him must be known and admitted by all. In the "Reliquiæ Diluvianæ," and in the eloquent "Inaugural Lecture," delivered at Oxford, he had already occupied with honour nearly the same ground on which the proposed treatise was to be reared. His extensive knowledge, both as a naturalist and geologist, together with his profession and the office he holds at one of our universities, pointed him out as eminently qualified to give effect to the intentions of the Earl of Bridgewater, himself a clergyman.

The science of geology has already been treated of with great ability, in forms more or less scientific, by a considerable number of authors, but the present work stands quite distinct from all which have preceded it. The object it has in view is to consider geology, in reference to natural theology alone, to consider the phenomena which it discloses, not merely as material agencies producing material effects, but as the operations of Omnipotent power and of Supreme intelligence, directed to the accomplishment both of present and of future ends. The object is to show not only that every part of the globe whereon we dwell is adapted and subservient to the wants of man, and the inferior creation by which he is surrounded; but to prove that these adaptations are not the work of chance, or of any imaginable concurrence of fortuitous circumstances, a course nearly similar to that pursued in the preceding "Bridgewater Treatises." But the argument takes even higher grounds than these, based on the magnificent discoveries of the last few years, it passes at once to the embryo state of our planet, and traces each successive change by which, during the progress of countless ages, it has assumed its present form and aspect. These changes, it is true, have been the result of material laws such as now govern the universe; but Dr. Buckland places before his readers the *prospective* ends which each of these revolutions have answered, and for which they must, therefore, have been *designed*: thus uniting in one grand whole, all which, as far as time is concerned, we shall ever learn from science of the operations of the Deity. And where, it may be asked, in the whole range of scientific discoveries, is a more magnificent scene opened to our conception than that of the Being who now "rides on the whirlwind and directs the storm," presiding at periods infinitely remote, over the vast physical revolutions of which our planet was then the scene, and directing them with prospective intelligence, to minister to the wants, the habits, and enjoyments of man, at a period when the human race existed only in the predestined councils of eternity?

But however strong the argument deduced from the mere physical actions of matter may be, reasoning still more forcible and conclusive is obtained when we open the mysterious volume of organised nature. Not only does this apply when we observe that organisation which we see around us, and which is contemporaneous with our own existence, but when piercing into the solid rocky fabric of the globe, we examine the forms and peculiarities of those other races of animated beings which existed in the most distant epochs of our planet, the zoophytes, the shells, the fishes, which inhabited the primeval ocean; the enormous reptiles which tenanted the first dry land and its adjacent waters; the strange and uncouth forms of extinct mammalia which first inhabited our new-born continent.

All these various forms of animal existence may now be shown to have formed the parts of one great whole, to be connected by the closest links with existing animals, or rather to have formed connecting links between them, which philosophers, although able to see were wanting, have hitherto had no means of supplying. These discoveries result, too, from no far-fetched analogy, no ingenious and plausible, though ill supported, theory. They are immediate deductions from admitted facts, they rest upon a firm and enduring basis of close and accurate observation, and the superstructure has been reared by the rigid process of inductive reasoning. Not only are we now able to arrange the innumerable *fossil* tribes of animals and vegetables in their proper places, as parts of one great scheme of creation, perfectly harmonising with those living types we see around us, but we may look back to the state of the earth at the period they existed, and we may prove that every peculiarity they possessed was as nicely adapted to existing circumstances, as are the peculiarities of existing organisation to the present condition of the globe.

The chimerical idea of *equivocal* or spontaneous generation, and of the indefinite *transmutation* of species, is now completely overthrown. It is well established that the various forms of fossil organisation could not by any modifying process (to use a geological expression) have *passed into each other*; and that the idea of indefinite transmutation into more perfect species, or of indefinite modification to suit the altered circumstances of the globe, are wild and visionary, and at total variance both with the actual phenomena and the established laws of Nature.

Thus, then, we are compelled to look upon each successive race of fossil organisation, not as the modified offspring of any similar type, but as a *new creation*, as a new and distinct act of Creative power and intelligence. Further than this, we may look back to a period when organised matter had *no existence*, when "the earth was without form and void," when the physical laws of matter alone prevailed, and we may almost fix the point when, as regards the history of our own planet, the page of animated nature was first imprinted by the finger of the Deity.

In thus tracing the wonderful results which the zeal, the sagacity, and the laborious research of philosophers, have produced, almost within the period of our own recollection, although many powerful minds have been engaged, each of which has reared a noble monument to its own fame, there is one whose name requires, even in our brief and hasty sketch, a high and honourable notice—the illustrious Cuvier, whose profound researches, it is still fresh in our recollection, have been arrested by the hand of death.

To show more distinctly the nature of those labours we have referred to, we must remind our readers that the extinct forms of fossil existence were never seen by human eye: the skin, the flesh, the internal organs, have decomposed, as at the present time, and have in almost every case left not a trace behind them. The principal relics we possess, therefore, are the disjointed bones and teeth, which, from their more durable nature, have been found in a more or less mineralised state, often very perfect individually, but very rarely presenting their natural arrangement, or affording more than a mutilated and imperfect skeleton.

Such, then, were the materials with which Cuvier had to work, and the grand problem he undertook to solve, was from this "charnel-house" of nature, to re-construct the original animals, to give them a "local habitation and a being"—to determine their species, their forms and habits. This task would indeed have baffled the sagacity of the most skilful philosopher, had not Nature herself afforded a key, in the *perfect correspondence and adaptation of all the parts of organised beings*—a law prevailing equally with fossil as with present existence. Deeply versed in comparative anatomy, and intimately acquainted with "the laws which preside at the co-existence of the forms of the various parts of organised beings"—the genius of Cuvier found the means of reducing this chaos to order, and not only of restoring the forms of extinct species, but of determining with accuracy the habits and peculiarities which distinguished them.

To use his own eloquent language in describing his labours—

"It was attempting to traverse an entire region, the first approaches to which were as yet scarcely known. An antiquary of a new order, it was necessary at the same time to restore these monuments of past revolutions, and to ascertain the facts they disclosed. I had to collect and arrange in their original order the component relics—to re-model the creatures to whom these fragments had belonged—to re-produce them in their just proportions, and with their peculiar characteristics, and, finally, to compare them with those beings now in existence—an art almost unknown, and implying a science which had before been scarcely even glanced at."—*Discourse on the Revolution of the Globe, prefixed to his great work* "Ossemens Fossiles."

We have now briefly glanced at the present state of geological science with reference to final causes—we have pointed out some of the grand facts which it has demonstrated, and given the reader some idea of the materials which Dr. Buckland has had to work with, in establishing the lofty argument which forms the subject of the work before us. We now return to the work itself, and shall trace the course of reasoning which he has adopted, illustrating our outline by frequent quotations of the most important passages, for although the treatise is doubtless in the hands of many of our readers, we fear the price is such as to prevent that general circulation which the work deserves—a remark which, we regret to observe, applies to the "Bridgewater Treatises" generally.

The following passages, extracted from the preface, will best show the nature and division of the argument:—

"Three important subjects of inquiry in Natural Theology come under consideration in the present Treatise.

"The first regards the inorganic elements of the mineral kingdom, and the actual dispositions of the materials of the earth: many of these, although produced or modified by the agency of violent and disturbing forces, afford abundant proofs of wise and provident intention, in their adaptations to the uses of the vegetable and animal kingdoms, and especially to the condition of man.

"The second relates to theories which have been entertained respecting the origin of the world; and the derivation of existing systems of organic life, by an eternal succession, from preceding individuals of the same species; or by gradual transmutation of one species into another. I have endeavoured to show, that to all these theories the phenomena of Geology are decidedly opposed.

"The third extends into the organic remains of a former world the same kind of investigation, which Paley has pursued with so much success in his examination of the evidences of design in the mechanical structure of the corporeal frame of man, and of the inferior animals which are placed with him on the present surface of the earth."

The introductory pages afford an admirable and striking illustration of the important effects which result from the peculiar geological structure of this, or indeed of any other country; showing how greatly both the numerical population, and the habits and employments they follow, and even their moral condition, may be influenced merely by the circumstance of residing on any particular rock or geological formation:—

"If a stranger, landing at the extremity of England, were to traverse the whole of Cornwall and the north of Devonshire; and crossing to St. David's, should make the tour of all North Wales; and passing thence through Cumberland, by the Isle of Man, to the south-western shore of Scotland, should proceed either through the hilly region of the Border counties, or, along the Grampians, to the German Ocean; he would conclude from such a journey of many hundred miles, that Britain was a thinly peopled sterile region, whose principal inhabitants were miners and mountaineers.

"Another foreigner, arriving on the coast of Devon, and crossing the Midland counties, from the mouth of the Exe, to that of the Tyne, would find a continued succession of fertile hills and valleys, thickly overspread with towns and cities, and in many parts crowded with a manufacturing population, whose industry is maintained by the coal with which the strata of these districts are abundantly interspersed.

"A third foreigner might travel from the coast of Dorset to the coast of Yorkshire, over elevated plains of oolitic limestone, or of chalk; without a single mountain, or mine, or coal-pit, or any important manufactory, and occupied by a population almost exclusively agricultural.

"Let us suppose these three strangers to meet at the termination of their journeys, and to compare their respective observations; how different would be the results to which each would have arrived, respecting the actual condition of Great Britain. The first would represent it as a thinly peopled region of barren mountains; the second, as a land of rich pastures, crowded with a flourishing population of manufacturers; the third, as a great corn field, occupied by persons almost exclusively engaged in the pursuits of husbandry.

"These dissimilar conditions of three great divisions of our country, result from differences in the geological structure of the districts through which our three travellers have been conducted. The first will have seen only those north-western portions of Britain, that are composed of rocks belonging to the primary and transition series: the second will have traversed those fertile portions of the new red sandstone formation which are made up of the detritus of more ancient rocks, and have beneath, and near them, inestimable treasures of mineral coal: the third will have confined his route to wolds of limestone, and downs of chalk, which are best adapted for sheep-walks, and the production of corn.

"Hence it appears that the numerical amount of our population, their varied occupations, and the fundamental sources of their industry and wealth, depend, in a great degree, upon the geological character of the strata on which they live. Their physical condition also, as indicated by the duration of life and health, depending on the more or less salubrious nature of their employments; and their moral condition, as far as it is connected with these employments, are directly affected by the geological causes in which their various occupations originate."

As regards the general diversity of mineral structure, Dr. Buckland proceeds to observe—

"From this example of our own country, we learn that the same constituent materials of the earth are not uniformly continuous in all directions over large superficial areas. In one district, we trace the course of crystalline and granitic rocks; in another, we find mountains of slate; in a third, alternating strata of sandstone, shale, and limestone; in a fourth, beds of conglomerate rock; in a fifth, strata of marl and clay; in a sixth, gravel, loose sand, and silt. The subordinate mineral contents of these various formations are also different; in the more ancient, are veins of gold and silver, tin, copper, lead, and zinc; in another series, we find beds of coal; in others, salt and gypsum; many are composed of freestone, fit for the purposes of architecture; or of limestone, useful both for building and cement; others of clay, convertible by fire into materials for building, and pottery; in almost all we find that most important of mineral productions, iron."

Dr. Buckland next proceeds to consider the "consistency of geological discoveries with Sacred History," an extremely difficult subject, but which, as might be expected, is treated with great moderation and ability. The following passages are remarkable for their justice, and important from the truths they convey:—

"It must be candidly admitted that the season has not yet arrived, when a perfect theory of the whole earth can be fixedly and finally established, since we have not yet before us all the facts on which such a theory may eventually be founded; but, in the mean while, we have abundant evidence of numerous and indisputable phenomena, each establishing important and undeniable conclusions; and the aggregate of these conclusions, as they gradually accumulate, will form the basis of future theories, each more and more nearly approximating to perfection; the first, and second, and third story of our edifice may be soundly and solidly constructed; although time must still elapse before the roof and pinnacles of the perfect building can be completed. Admitting therefore, that we have yet much to learn, we contend that much sound knowledge has been already acquired; and we protest against the rejection of established parts, because the whole is not yet made perfect." * * * * * *

"The disappointment of those who look for a detailed account of geological phenomena in the Bible, rests on a gratuitous expectation of finding therein historical information, respecting all the operations of the Creator in times and places with which the human race has no concern; as reasonably might we object that the Mosaic history is imperfect, because it makes no specific mention of the satellites of Jupiter, or the rings of Saturn, as feel disappointment at not finding in it the history of geological phenomena, the details of which may be fit matter for an encyclopedia of science, but are foreign to the objects of a volume intended only to be a guide of religious belief and moral conduct.

"We may fairly ask of those persons who consider physical science a fit subject for revelation, what point they can imagine short of a communication of Omniscience, at which such a revelation might have stopped, without imperfections of omission, less in degree, but similar in kind, to that which they impute to the existing narrative of Moses? A revelation of so much only of astronomy, as was known to Copernicus, would have seemed imperfect after the discoveries of Newton; and a revelation of the science of Newton would have appeared defective to La Place: a revelation of all the chemical knowledge of the eighteenth century would have been as deficient in comparison with the information of the present day, as what is now known in this science will probably appear before the termination of another age: in the whole circle of sciences, there is not one to which this argument may not be extended, until we should require from revelation a full development of all the mysterious agencies that uphold the mechanism of the material world. Such a revelation might indeed be suited to beings of a more exalted order than mankind, and the attainment of such knowledge of the works as well as of the ways of God, may perhaps form some part of our happiness in a future state; but unless human nature had been constituted otherwise than it is, the above supposed communication of omniscience would have been imparted to creatures, utterly incapable of receiving it, under any past or present moral or physical condition of the human race; and would have been also at variance with the design of all God's other disclosures of himself, the end of which has uniformly been, not to impart intellectual but moral knowledge."

The view which Dr. Buckland takes of the subject under consideration, appears to be the same he has long entertained, and is briefly summed up in the following passage:—

"In my inaugural lecture, published at Oxford, 1820, pp. 31, 32, I have stated my opinion in favour of the hypothesis, 'which supposes the word *beginning*, as applied by Moses in the first verse of the book of Genesis, to express an undefined period of time, which was antecedent to the last great change that affected the surface of the earth, and to the creation of its present animal and vegetable inhabitants; during which period a long series of operations and revolutions may have been going on; which, as they are wholly unconnected with the history of the human race, are passed over in silence by the sacred historian, whose only concern with them was barely to state, that the matter of the universe is not eternal and self-existent, but was originally created by the power of the Almighty.'"

In allusion to this opinion, he continues—

"I have great satisfaction in finding that the view of this subject, which I have here expressed, and have long entertained, is in perfect accordance with the highly valuable opinion of Dr. Chalmers, recorded in the following passages of his Evidence of the Christian Revelation, chap. vii.:—'Does Moses ever say, that when God created the heavens and the earth he did more, at the time alluded to, than transform them out of previously existing materials? Or does he ever say that there was not an interval of many ages between the first act of creation described in the first verse of the Book of Genesis, and said to have been performed at the *beginning*, and those more detailed operations, the account of which commences at the second verse, and which are described to us as having been performed in so many days? Or, finally, does he ever make us to understand that the genealogies of man went any farther than to fix the antiquity of the species, and, of consequence, that they left the antiquity of the globe a free subject for the speculation of philosophers?'"

With these opinions, entitled to every respect from the learning and ability of the individuals by whom they are advanced, we quit the consideration of this embarrassed and difficult question, although inclined to believe that another and equally satisfactory mode of explanation presents itself. We shall now proceed to subjects which come more properly within the strict province of geological inquiry, the nature and relation of the mineral constituents of our planet. After some preliminary observations, Dr. Buckland observes—

"Before we enter on the history of fossil animals and vegetables, we must therefore first briefly review the progressive stages of mineral formations; and see how far we can discover in the chemical constitution, and mechani-

cal arrangement of the materials of the earth, proofs of general prospective adaptation to the economy of animal and vegetable life.

"As far as our planet is concerned, the first act of creation seems to have consisted in giving origin to the elements of the material world. These inorganic elements appear to have received no subsequent addition to their number, and to have undergone no alteration in their nature and qualities; but to have been submitted at their creation to the self-same laws that regulate their actual condition, and to have continued subject to these laws during every succeeding period of geological change. The same elements also which enter the composition of existing animals and plants, appear to have performed similar functions in the economy of many successive animal and vegetable creations."

Referring to a very ingenious "Ideal Section of a portion of the Earth's Crust," which forms the first illustration of the work, Dr. Buckland continues—

"From the above section it appears that there are eight distinct varieties of the crystalline unstratified rocks, and twenty-eight well-defined divisions of the stratified formations. Taking the average maximum thickness of each of these divisions at one thousand feet, we should have a total amount of more than five miles; but as the transition and primary strata very much exceed this average, the aggregate of all the European stratified series may be considered to be at least ten miles."

Speaking of the "relation of unstratified to stratified rocks," the author observes—

"As the materials of stratified rocks are in great degree derived, directly or indirectly, from those which are unstratified, it will be premature to enter upon the consideration of derivative strata, until we have considered briefly the history of the primitive formations. We therefore commence our inquiry at that most ancient period, when there is much evidence to render it probable that the entire materials of the globe were in a fluid state, and that the cause of this fluidity was heat. The form of the earth being that of an oblate spheroid, compressed at the poles, and enlarged at the equator, is that which a fluid mass would assume from revolution round its axis. The further fact, that the shortest diameter coincides with the existing axis of rotation, shows that this axis has been the same ever since the crust of the earth attained its present solid form.

"Assuming that the whole materials of the globe may have once been in a fluid, or even a nebular state, from the presence of intense heat, the passage of the first consolidated portions of this fluid, or nebulous matter, to a solid state, may have been produced by the radiation of heat from its surface into space; the gradual abstraction of such heat would allow the particles of matter to approximate and crystallize; and the first result of this crystallization might have been the formation of a shell or crust, composed of oxidated metals and metalloids, constituting various rocks of the granitic series, around an incandescent nucleus, of melted matter, heavier than granite; such as forms the more weighty substance of basalt and compact lava."

The proofs of design afforded not only by the *accumulation*, but by the subsequent *elevation*, of the derivative strata, are thus described:—

"The detritus of the first dry lands being drifted into the sea, and there spread out into extensive beds of mud and sand and gravel, would for ever have remained beneath the surface of the water, had not other forces been subsequently employed to raise them into dry land: these forces appear to have been the same expansive powers of heat and vapour which, having caused the elevation of the first raised portions of the fundamental crystalline rocks, continued their energies through all succeeding geological epochs, and still exert them in producing the phenomena of active volcanoes; phenomena incomparably the most violent that now appear upon the surface of our planet." * * * * * *

"All observers admit that the strata were formed beneath the water, and have been subsequently converted into dry land; and whatever may have been the agents that caused the movements of the gross unorganized materials of the globe, we find sufficient evidence of prospective wisdom and design, in the benefits resulting from these obscure and distant revolutions, to future races of terrestrial creatures, and more especially to man."

Dr. Buckland thus continues the consideration of this branch of the subject:—

"In unstratified crystalline rocks, wholly destitute of animal or vegetable remains, we search in vain for those most obvious evidences of contrivance, which commence with the first traces of organic life, in strata of the transition period; the chief agencies which these rocks indicate, are those of fire and water; and yet even here we find proof of a system and intention, in the purpose which they have accomplished, of supplying and accumulating at the bottom of the water the materials of stratified formations, which, in after times, were to be elevated into dry lands, in an ameliorated condition of fertility. Still more decisive are the evidences of design and method, which arise from the consideration of the structure and composition of their crystalline mineral ingredients. In every particle of matter to which crystallization has been applied, we recognise the action of those undeviating laws of polar forces, and chemical affinity, which have given to all crystallized bodies a series of fixed definite forms and definite compositions. Such universal prevalence of law, method, and order, assuredly attests the agency of some presiding and controlling mind.

"A further argument, which will be more insisted on in speaking on the subject of metallic veins, may be founded on the dispensation whereby the primary and transition rocks are made the principal repositories of many valuable metals, which are of such peculiar and indispensable importance to mankind."

After an eloquent description of volcanic movements, and the sensations they occasion in districts where they prevail, we find the following passage:—

"The sources from which the matter of these ejected rocks ascends are deeply seated beneath the granite; but it is not yet decided whether the immediate cause of an eruption be the access of water to local accumulations of the metalloid bases of the earths and alkalies; or whether lava be derived directly from that general mass of incandescent elements, which may probably exist at a depth of about one hundred miles beneath the surface of our planet."

On fossil organization we have the following admirable remarks:—

"As, in the consideration of other strata, we find abundant evidence in the presence of organic remains, in proof of the exercise of creative power, and wisdom, and goodness, attending the progress of life, through all its stages of advancement upon the surface of the globe; so, from the absence of organic remains in the primary strata, we may derive an important argument, showing that there was a point of time in the history of our planet (which no other researches but those of geology can possibly approach), antecedent to the beginning of either animal or vegetable life. This conclusion is the more important, because it has been the refuge of some speculative philosophers to refer the origin of existing organizations, either to an eternal succession of the same species, or to the formation of more recent from more ancient species, by successive developments, without the interposition of direct and repeated acts of creation; and thus to deny the existence of any first term, in the infinite series of successions which this hypothesis assumes. Against this theory, no decisive evidence has been accessible, until the modern discoveries of geology had established two conclusions of the highest value in relation to this long disputed question; the first proving, that existing species have had a beginning; and this at a period comparatively recent in the physical history of our globe: the second showing that they were preceded by several other systems of animal and vegetable life, respecting each of which it may no less be proved, that there was a time when their existence had not commenced; and that to these more ancient systems also, the doctrine of eternal succession, both retrospective and prospective, is equally inapplicable."

On the animal remains of the transition series, Dr. Buckland observes—

"Beginning with the animal kingdom, we find the four great existing divisions of *Vertebrata, Mollusca, Articulata*, and *Radiata*, to have been coeval with the commencement of organic life upon our globe."

The following description of the vegetable remains and mineral contents of the same series, and the arguments connected with them, are so intimately connected with the immediate province of this Journal, that we transcribe them almost entire. The reasoning cannot indeed be said to possess novelty, but it is distinguished alike by force and eloquence:—

"In the inferior regions of this series plants are few in number, and principally marine; but in its superior regions the remains of land plants are accumulated in prodigious quantities, and preserved in a state which gives them a high and two-fold importance; first, as illustrating the history of the earliest vegetation that appeared upon our planet, and the state of climate and geological changes which then prevailed; secondly, as affecting, in no small degree, the actual condition of the human race.

"The strata in which these vegetable remains have been collected together in such vast abundance have been justly designated by the name of the carboniferous order, or great coal formation. (See Conybeare and Phillips' Geology of England and Wales, book iii.) It is in this formation chiefly, that the remains of plants of a former world have been preserved and converted into beds of mineral coal; having been transported to the bottom of former seas and estuaries, or lakes, and buried in beds of sand and mud, which have since been changed into sandstone and shale.

"Besides this coal, many strata of the carboniferous order contain subordinate beds of a rich argillaceous iron ore, which the near position of the coal renders easy of reduction to a metallic state; and this reduction is further facilitated by the proximity of limestone, which is requisite as a flux to separate the metal from the ore, and usually abounds in the lower regions of the carboniferous strata.

"A formation that is at once the vehicle of two such valuable mineral productions as coal and iron, assumes a place of the first importance among the sources of benefit to mankind; and this benefit is the direct result of physical changes which affected the earth at those remote periods of time, when the first forms of vegetable life appeared upon its surface.

"The important uses of coal and iron in administering to the supply of our daily wants, give to every individual amongst us, in almost every moment of our lives, a personal concern, of which but few are conscious, in the geological events of these very distant eras. We are all brought into immediate connexion with the vegetation that clothed the ancient earth, before one-half of its actual surface had yet been formed. The trees of the primeval forests have not, like modern trees, undergone decay, yielding back their elements to the soil and atmosphere by which they had been nourished; but, treasured up in subterranean storehouses, have been transformed into enduring beds of coal, which in these later ages have become to man the sources of heat, and light, and wealth. My fire now burns with fuel, and my lamp is shining with the light of gas, derived from coal that has been buried for countless ages in the deep and dark recesses of the earth. We prepare our food, and maintain our forges and furnaces, and the power of our steam-engines, with the remains of plants of ancient forms and extinct species, which were swept from the earth, ere the formation of the transition strata was completed. Our instruments of cutlery, the tools of our mechanics, and the countless machines which we construct, by the infinitely varied applications of iron, are derived from ore, for the most part coeval with, or more ancient than the fuel, by the aid of which we reduce it to its metallic state, and apply it to innumerable uses in the economy of human life. Thus, from the wreck of forests that waved upon the surface of the primeval lands, and from ferruginous mud that was lodged at the bottom of the primeval waters, we derive our chief supplies of coal and iron; those two fundamental elements of art and industry, which contribute more than any other mineral production of the earth, to increase the riches, and multiply the comforts, and ameliorate the condition of mankind."

On the proofs of design exhibited by the secondary series of formations, Dr. Buckland very justly observes—

"With regard to their adaptation to human uses, it may be stated generally, that the greater number of the most populous and highly civilized assemblages of mankind inhabit those portions of the earth which are composed of secondary and tertiary formations. Viewed, therefore, in their relations to that agricultual stage of human society in which man becomes established in a settled habitation, and applies his industry to till the earth, we find in these formations which have been accumulated, in apparently accidental succession, an arrangement highly advantageous to the cultivation of their surface. The movements of the waters, by which the materials of strata have been transported to their present place, have caused them to be intermixed in such manner, and in such proportions, as are in various degrees favourable to the growth of the different vegetable productions, which man requires for himself and the domestic animals he has collected around him."

On the admirable contrivances exhibited for the distribution and supply of that most essential element, *water*, we find the following remarks:—

"Another advantage in the disposition of stratified rocks consists in the fact that strata of limestone, sand, and sandstone, which readily absorb water, alternate with beds of clay, or marl, which are impermeable to this most important fluid. All permeable strata receive rain-water at their surface, whence it descends until it is arrested by an impermeable subjacent bed of clay, causing it to accumulate throughout the lower region of each porous stratum, and to form extensive reservoirs, the overflowings of which on the sides of valleys constitute the ordinary supply of springs and rivers. These reservoirs are not only occasional crevices and caverns, but the entire space of all the small interstices of those lower parts of each permeable stratum, which are beneath the level of the nearest flowing springs. Hence if a well be sunk to the water-bearing level of any stratum, it forms a communication with a permanent subterranean sheet of water, affording plentiful supplies to the inhabitants of upland districts, which are above the level of natural springs."

A somewhat similar argument is next derived from the very general distribution of that very essential article *salt*, in one of the most widely-extended formations of the secondary series, the new red sandstone.

Animal life, as exhibited in this series, is thus described:—

"With respect to the state of animal life, during the deposition of the secondary strata, although the petrified remains of Zoophytes, Crustacea, Testacea, and fishes, shows that the seas in which these strata were formed, like those which gave birth to the Transition series, abounded with creatures referable to the four existing divisions of the animal kingdom, still the condition of the globe seems not yet to have been sufficiently advanced in tranquillity to admit of general occupation by warm-blooded terrestrial Mammalia."

The strata of the tertiary series, are introduced by the following general remarks:—

"The tertiary series introduces a new system of phenomena, presenting formations in which the remains of animal and vegetable life approach gradually nearer to species of our own epoch. The most striking feature of these formations consists in the repeated alternations of marine deposits, with those of fresh water.

"We are indebted to Cuvier and Brogniart for the first detailed account of the nature and relations of a very important portion of the tertiary strata, in their inestimable history of the deposits above the chalk near Paris. For a short time these were supposed to be peculiar to that neighbourhood; further observation has discovered them to be parts of a great series of general formations, extending largely over the whole world, and affording evidences of at least four distinct periods, in their order of succession, indicated by changes in the nature of the organic remains that are imbedded in them.

"Throughout all these periods, there seems to have been a continually increasing provision for the diffusion of animal life, and we have certain evidence of the character and numbers of the creatures that were permitted to enjoy it, in the multitude of shells and bones preserved in the strata that were deposited during each of the four epochs we are considering."

After describing the various forms of animal life occurring in this series, as demonstrated by the discoveries of Cuvier and other naturalists, Dr. Buckland remarks—

"It appears that the animal kingdom was thus early established, on the same general principles that now prevail; not only did the four present classes of Vertebrata exist; and among Mammalia, the orders Pachydermata, Carnivora, Rodentia, and Marsupialia; but many of the genera also, into which living families are distributed, were associated together in the same system of adaptations and relations, which they hold to each other in the actual creation. The Pachydermata and Rodentia were kept in check by the Carnivora—the Gallinaceous birds were controlled by the Accipitres.
* * * * * * *

"This numerical preponderance of Pachydermata, among the earliest fossil Mammalia, beyond the proportion they bear among existing quadrupeds, is a remarkable fact, much insisted on by Cuvier; because it supplies, from the relics of a former world, many intermediate forms which do not occur in the present distribution of that important order. As the living genera of Pachydermata are more widely separated from one another, than those of any other order of Mammalia, it is important to fill these vacant intervals with the fossil genera of a former state of the earth; thus supplying links that appeared deficient in the grand continuous chain which connects all past and present forms of organic life, as parts of one great system of creation."

It is observed that the fresh-water calcareous deposits of the tertiary period, are highly important as illustrating the general history of the origin of limestone, and affording strong evidence of the sources whence the carbonate of lime so largely entering into the composition of the crust of the globe has been derived. Dr. Buckland's views coincide with those of Mr. De la Beche and other geologists, and are thus explained in a note:—

"We see that thermal springs, in volcanic districts, issue from the earth, so highly charged with carbonate of lime, as to overspread large tracts of country with beds of calcareous tufa, or travertino. The waters that flow from the Lago di Tartaro, near Rome, and the hot springs of San Filippo, on the borders of Tuscany, are well known examples of this phenomenon. These existing operations afford a nearly certain explanation of the origin of extensive beds of limestone in fresh-water lakes of the tertiary period, where we know them to have been formed during seasons of intense volcanic activity. They seem also to indicate the probable agency of thermal waters in the formation of still larger calcareous deposits at the bottom of the sea, during preceding periods of the secondary and transition series.

"It is a difficult problem to account for the source of the enormous masses of carbonate of lime that compose nearly one-eighth part of the superficial crust of the globe. Some have referred it entirely to the secretions of marine animals; an origin to which we must obviously assign those portions of calcareous strata which are composed of comminuted shells and corallines: but, until it can be shown that these animals have the power of forming lime from other elements, we must suppose that they derived it from the sea, either directly, or through the medium of its plants. In either case, it remains to find the source whence the sea obtained, not only these supplies of carbonate of lime for its animal inhabitants, but also the still larger quantities of the same substance, that have been precipitated in the form of calcareous strata.

"We cannot suppose it to have resulted, like sands and clays, from the mechanical detritus of rocks of the granitic series, because the quantity of lime these rocks contain, bears no proportion to its large amount among the derivative rocks. The only remaining hypothesis seems to be, that lime was continually introduced to lakes and seas, by water that had percolated rocks through which calcareous earth was disseminated."

The notice of the tertiary series is concluded by the following passage:—

"Every comparative anatomist is familiar with the beautiful examples of mechanical contrivance and compensations, which adapt each existing species of herbivora and carnivora to its own peculiar place and state of life. Such contrivances began not with living species: the geologist demonstrates their prior existence in the extinct forms of the same genera which he discovers beneath the surface of the earth, and he claims for the Author of these fossil forms under which the first types of such mechanisms were embodied, the same high attributes of wisdom and goodness, the demonstration of which exalts and sanctifies the labours of science, in her investigation of the organizations of the living world."

Dr. Buckland then proceeds to consider the "Relation of the Earth and its Inhabitants to Man." Speaking of possible arrangements of the globe, other than those actually existing, we have the following remarks:—

"We shall form a better estimate of the utility of the complex disposition of the materials of the earth, which has resulted from the operations of all these mighty conflicting forces, if we consider the inconveniences that might have attended other arrangements, more simple than those which actually exist. Had the earth's surface presented only one unvaried mass of granite or lava; or, had its nucleus been surrounded by entire concentric coverings of stratified rocks, like the coats of an onion, a single stratum only would have been accessible to its inhabitants; and the varied intermixtures of limestone, clay, and sandstone, which, under the actual disposition, are so advantageous to the fertility, beauty, and habitability, of the globe, would have had no place.

"Again, the inestimably precious treasures of mineral salt and coal, and of metallic ores, confined as these latter chiefly are, to the older series of formations, would, under the supposed more simple arrangement of the strata, have been wholly inaccessible; and we should have been destitute of all these essential elements of industry and civilisation. Under the existing disposition, all the various combinations of strata with their valuable contents, whether produced by the agency of subterranean fire, or by mechanical, or chemical deposition beneath the water, have been raised above the sea, to form the mountains and the plains of the present earth; and have still further been laid open to our reach, by the exposure of each stratum, along the sides of valleys.

"With a view to human uses, the production of a soil fitted for agriculture, and the general dispersion of metals, more especially of that most important metal iron, were almost essential conditions of the earth's habitability by civilised man."

The following extract from Bakewell's "Introduction to Geology," forms the conclusion of the view given of this part of the subject:—

"'More than three-fifths of the earth's surface,' says Mr. Bakewell, 'are covered by the ocean; and if from the remaining part we deduct the space occupied by polar ice and eternal snow, by sandy deserts, sterile mountains, marshes, rivers and lakes, the habitable portion will scarcely exceed one-fifth of the whole of the globe. Nor have we reason to believe that at any former period the dominion of man over the earth was more extensive than at present. The remaining four-fifths of our globe, though untenanted by mankind, are for the most part abundantly stocked with animated beings, that exult in the pleasure of existence, independent of human control, and no way subservient to the necessities or caprices of man. Such is, and has been for several thousand years, the actual condition of our planet; nor is the consideration foreign to our subject, for hence we may feel less reluctance in admitting the prolonged ages or days of creation, when numerous tribes of the lower orders of aquatic animals lived and flourished, and left their remains imbedded in the strata that compose the outer crust of our planet.' Bakewell's Introduction to Geology, 4th edit., p. 6."

There is much force and justice in this view of the subject; and when we see, that even under the present order of things, so large a portion of the globe is set apart for the lower orders of creation, we have a new and forcible, and at the same time, unexpected, argument, in favour of the fact demonstrated by geology, that there has been a period, and that, too, of no inconsiderable duration, when they alone, were the tenants of the globe.

(To be continued.)

The Miner's Guide; being a description and illustration of a Chart of Sections of the principal Mines of Coal and Ironstone in the Counties of Stafford, Salop, Warwick, and Durham. By THOMAS SMITH, Mine and Land Agent, Sandy-field, near Sedgley. London, 1836: C. Tilt, Fleet-street; Radycliffe and Co., Birmingham.

On the first appearance of this publication, about a month since, we recommended it to the favourable notice of our readers, and a subsequent perusal has fully confirmed the good opinion we then entertained of it.

Every addition made to our knowledge of the Coal and Iron Mines of this country must be acceptable—more especially when, as in the present case, we have clearly and intelligibly placed before us the facts and data accumulated during many years of active and practical experience. To the geologist these facts are valuable, as forming the very foundations of the superstructure he is engaged in rearing,—to the miner they are important, assisting to guide, by the light of past experience, the operations which it is his business to execute or superintend,—to the speculator and capitalist they are not without value, as they present a standard of comparison by which assumed and magnificent results may at once be brought to the sober test of truth and reason.

The work before us consists of a large and handsome *Chart*, containing well-engraved sections of many of the principal coal and iron mines in the midland and northern counties. These sections, the accuracy of which is well authenticated, exhibit clearly and distinctly the thickness and nature of every stratum met with in sinking the pits, in the mines to which they refer. The position and thickness of every seam of coal and ironstone is noted, and the whole illustrated by an excellent surface view of a coal mine, showing the operation of winning the coal, the various machinery employed, &c. &c.

The Chart is accompanied by a small descriptive volume, containing a great deal of useful information on local subjects and mining operations, and many excellent tables, showing the cost of "getting" the coal, by different modes of working. At the end of the volume is a convenient letter-press description of the various sections given in the Chart.

We shall now proceed to make some extracts from the work, which will enable our readers to judge for themselves of its merits; and we heartily recommend it to all who may be interested in, or connected with, the important mineral districts to which it refers. We are glad, indeed, to observe that a numerous and highly-respectable list of subscribers is prefixed to the volume.

The following passage, explaining the author's views, is taken from the preface. After some preliminary observations, he continues—

"Such considerations as these, added to the strongly expressed wishes of several judicious friends, have induced the author, at the close of a life devoted, from an early age, to active employment connected with the mines of North and South Staffordshire and Warwickshire, from the mass of memoranda and recorded observation which he has accumulated, to compile the present work, and the elaborate chart or table of sections which it is especially intended to accompany and illustrate. The aim has been to exhibit a complete view of the stratification of the coal and ironstone mines in different localities, in those districts with which the author has been most conversant, together with a more brief notice of some of the principal distant coal-fields; with full statements of the cost of getting, with the various collateral expenses attendant thereon; calculations of royalty, profit, and value per acre;—the range of information extending with more or less precise detail over the mines of South Staffordshire, North Staffordshire, Shropshire, and Warwickshire, with a less detailed account of those of Lancashire and Durham.

"The execution of such a work necessarily involved great research and close observation of facts, and the attention given to the execution of it has been minute and unwearied. The calculations of the production of the coal and ironstone per yard and per acre, have been made with the greatest care, and the best voucher for their correctness is the circumstance that the author has had frequent facilities of access to, or has been directly or indirectly concerned in the working of nearly all the mines he has selected for his chart, and which he has particularly described in this volume. Indeed it has been his wish to claim for his work the character of General Guide or Directory,

and to insp re confidence by a display of the resources of the country, and at the same time, by a minute description of the faults and other interruptions, pointing out the varying and uncertain value of mining property, and the great necessity which exists for caution in relation to mining undertakings.

"In the descriptive portion of the work the most unreserved information is offered as to the modes of extracting the different strata, displaying, according to the most approved practice, the manner of opening the pits, and of driving the various excavations, under the technical denomination of gate-roads, levels, and waggon-roads, by which access is obtained to every part of the mine in succession, and the most practicable means secured of removing the produce, drawing it up to the surface by means of the engine, and of conveying it to the point at which it is to be deposited, in readiness for land or water carriage.

"In all these details reference is made to the expense of executing each species of the required labour, including the arrangement of the pits, pumps, and engines, so as to render the work practically useful in every possible way."

The great Staffordshire Coal Field is thus described :—

"The South Staffordshire coal and ironstone mines occupy an area nearly twenty-two miles in length, from Stourbridge, in Worcestershire, to the neighbourhood of Rugeley, and about six miles in its greatest breadth; the total superficial contents being nearly ninety square miles. But this extended space is divisible into two distinct portions, of which the southern is circumscribed by a line drawn from Wolverhampton, through Walsall, West Bromwich, Oldbury, Halesowen, Stourbridge, King-Swinford, and Sedgley, to the point of its commencement at Wolverhampton. Within this latter circuit is confined the great and important stratum, called, from its average thickness, the Ten Yard Coal, which, beyond this boundary, either ceases or divides itself into beds of inconsiderable thickness, or lies too deep to be reached.

"The coal and ironstone procured from the mines of this district are both of the first quality. The metal produced is brought into the market as pig, or bar and rod iron, according to the mode of its treatment; and is applicable to nearly all purposes of arts and manufacture. Much of it is consumed in the various foundries in the neighbourhood, and in that busy emporium of the mechanical arts, the town of Birmingham. Vast quantities are also sent to London, Liverpool, and other places. The coal is raised in quantities almost inconceivably great, and is used for the supply of the hundred furnaces which are thickly placed in this district—for the various operations of the forge, the foundry, and the numerous branches of manufacture which are congregated in the neighbourhood—and for domestic purposes. Much is also sent to a distance; into the farther parts of Warwickshire, into Northamptonshire, and other quarters. For the easy transit of these heavy materials canals are constructed, which diverge from this focus of operation, and radiate in every direction. The great road from Birmingham to Holyhead, Liverpool, and Manchester, also traverses it, and it is crossed by the line of the projected railway in the same direction.

"Throughout the greater portion of this southern half of the coal field the order of stratification appears to a certain extent similar, but the distance from the surface, at which any given stratum is found, various greatly in different situations. Thus, towards the centre of the district, the ten yard coal lies at the depth of 140 yards or upwards; but as we proceed northward the depth decreases, and the upper beds in succession are wanting, till, in the neighbourhood of Bilston, the thick coal itself comes to the surface, or *crops out*, as it is termed, and is lost. From this point, still ascending northward, coal is found at Bloxwich, through Cannock Chase and Beaudesert Park, but the strata are comparatively thin, and are probably the continuation, in a form more or less varied, of the lower mines or beds which are found under the thick coal in the southern part of the coal field.

"It appears, therefore, through the entire district, that there is a gradual slope or *dip* of the strata from north to south. This great general feature must be borne in mind, and will afford a key to many of the phenomena which the inspection of our chart of sections presents. Presuming, in accordance with the geological theory, of which we presented a brief outline, that all the strata were successively deposited by aqueous action, and consequently in a position horizontal, or nearly so; the supposition follows that the entire field must have been subjected to the action of immense moving powers, sufficient to elevate the continued face of the stratification in the manner we have described; and that the thick coal and its overlying beds, which are found in regular succession in the deeper situations, have been in the course of ages gradually reduced in the elevated parts, and their components dispersed, causing the various strata, as we see them in the different mines, to rise or *crop out* in succession, and thus forming a comparatively levelled surface.

"Such is the position of the coal strata in reference to their situation from north to south; but still greater and more remarkable variations are observable in other directions, where the great substratum of limestone is elevated from the depths at which it was originally formed. The results of these tremendous operations of nature are strikingly exhibited at Dudley, where the limestone forms the principal constituent of considerable eminences, and where it is raised from its original horizontal position, and presents itself at various angles, from thirty to eighty degrees; and at Walsall, where the slope is more gradual, but where it just emerges above the level surface of the earth. Other similar appearances occur in other parts, and in all cases the overlying strata, as they approach the point of elevation, become thinner, and are rendered indistinct and of little value—thus indicating the truth of the theory, which presumes that the limestone was *gradually raised* during the period when the depositions were forming; the natural consequence of which would be that the succeeding strata would be less and less perfectly developed, and that the operation of atmospheric phenomena, and the action of water, in the lapse of after-ages, would scatter and disperse the exposed edges of the strata, which were subjected to their influence.

"The fact of the existence of this bed of limestone, as a continuous substratum under-lying the coal measures through the *deep* of the coal-field, is not entirely left to be conjectured, or to be inferred from analogy, but is found to be fact in various mining works, where, from any cause, the operation has been carried on to a sufficient depth in the order of stratification, below the ten yard or main coal. Such is the case at Hill-top, in the parish of West Bromwich, and again at Dudley Port, in both which instances the limestone is reached at the depth of about 180 yards from the surface, the shaft, in the latter case, having cut through a *fault*, where the great and abrupt change of level has raised the lime so as to be only a little lower than the ten yard coal, to obtain which the pit had been sunk."

From the account of mining operations in Staffordshire, we extract the following :—

"As a greater or less quantity of water is almost always found in coal mines, the means of getting rid of this annoyance, are a source of anxious attention. The springs which are found in the course of the shaft itself, are carefully stopped by means of the brick-work or other material with which they are lined. The water which issues from the working strata is pumped up by a proper application of a portion of power from the whimsey or working-engine; but if the quantity be very great, it is necessary to have an additional engine, termed the *mine* or *water-engine*, to clear the pit. This is sometimes required of great power, and a third shaft is sunk for the reception of the pumps which it works.

"In certain situations one powerful water-engine is made to drain several collieries. In this case a narrow passage or channel, called the *main level*, is driven or excavated, so as to command a fall from the different works—from each of which descends a *head* or *level*, in order to convey the water to the main level, from which it is drawn by the water-engine placed at the lowest point.

"The shafts are usually from six to seven feet in diameter; the latter dimension is preferable, as giving freer passage to the skips which come up loaded with 15 or 20 cwt. of coal. The skips themselves are three feet six inches to three feet nine inches square, and the coal piled on them is kept from scattering by means of loose hoops of sheet-iron, which are laid round it while being placed upon the skip, and is farther secured by chains which pass over the whole. For the service of two pits of moderate depth, an engine of twenty-horse-power is required, of which the cost is from 400*l.* to 500*l.* The *stroke* or descent of the piston should be five feet.

"The pit is generally lined with good brick-work, except in certain parts where it passes through rock of hardness sufficient to render the lining unnecessary. It sometimes happens, however, that the shaft has to be cut through a bed of sand, so loose, or so full of water, that the sides cannot be supported while the bricking is executed. In this case the ingenuity of the manager of the work is exercised to discover the means of overcoming the difficulty. This is frequently done by means of open cylinders of cast-iron, of the proper diameter, of which one being let down to the quicksand, the digging proceeds with all possible speed, extending under the circumference of the cylinder till it sinks to a given depth. Another cylinder of the same diameter is then lowered, and placed accurately on the first, and the work proceeds; the two cylinders sinking together, and a third, a fourth, or a larger number if required, being placed in succession one upon the other, the whole range still gravitates downwards, till the loose and watery sand be passed.

"The shafts are usually sunk till the most valuable measures be reached, as the getting of this naturally produces the quickest return. The stratum first worked in South Staffordshire is, therefore, the Ten Yard Coal, as being vastly more productive than any other. But, as in the course of our details, it seems as advisable to proceed in our account of the produce and expense of working the various beds, in the order in which they occur, we commence with the Brooch Coal, which is, technically, the first *getable* stratum; that is, the first which is of sufficient thickness to yield a profit to the miner, and which is found at a considerable distance above the thick or ten yard coal."

Journal of the Franklin Institute of the State of Pennsylvania, and Mechanics' Register; devoted to Mechanical and Physical Science, Civil Engineering, the Arts and Manufactures, and the recording of American and other Patented Inventions. Edited by Thos. P. Jones, M.D., &c. &c. Philadelphia, 1836.

The numbers of this publication for July, August, and September, are now before us, and we beg to acknowledge the courtesy of the "Franklin Institute, of the State of Pennsylvania," in thus forwarding them, while it will ever afford us pleasure to reciprocate in an interchange of scientific information.

The character of the work appears to be intermediate between our own "Philosophical Magazine" and our "Mechanics' Magazine;" for, while on the one hand considerable space is devoted to subjects connected with engineering, practical mechanics, patents, &c., on the other we may quote several valuable papers connected with the higher branches of general science. We have much pleasure in recommending the work to the favourable notice of our readers, as the rapid progress of science and useful arts in America must ever be a subject of interest to ourselves. The same talent and ingenuity, and the same enterprising spirit which has raised Great Britain so high in the scale of nations, is possessed in a high degree by our trans-Atlantic brethren, but it there operates under new circumstances, and on elements perhaps still more favourable to its perfect development.

We extract the following paper "On Calcareous Cements," by James Frost, C.E., from the number for July—it affords an excellent example of the application of chemical and scientific knowledge to one of the most ordinary and simple processes of art :—

"Having seen the intense affinity between lime and water, we will now endeavour to examine the superior affinity between lime and carbonic acid; with which lime is always found naturally and definitely combined in the proportion of twenty-eight lime and twenty-two carbonic acid. It is also generally or always found mixed, and seemingly in combination with other substances; for, in the purest white Italian marble I have always found some minute silicious particles. Yet, carbonate of lime we shall hereafter find is never chemically combined with those other substances—whatever may be the hardness or specific gravity of the mass;—and as this is seemingly a position of some importance in geological investigations, it will be hereafter adverted to in connexion with another part of equal importance, when we have had the advantage of considering some other combinations of lime.

"In England, lime is generally procured by calcining the carbonates in two different modes. The one and most frequent, is the cheapest and easiest in practice, but the lime obtained in this way is generally found inferior in quality to that obtained by the more troublesome and expensive process.

"As lime of as good quality may be obtained by the easier process, we will endeavour to describe the necessary conditions. In the first mode, the carbonate is interstratified with the smallest and cheapest coal, in inverted lime kilns, and the fuel being in actual contact, acts with the greatest effect. The kilns are of the cheapest construction and maintenance, and being daily emptied of a portion of calcined lime, and daily charged with an equal proportion of fresh materials, the business is regularly conducted in the easiest manner—but the lime thus obtained is of a variable quality from some causes which must be explained, in order to be avoided.

"In the second mode the carbonates are piled in kilns so constructed that the fuel is burned in furnaces, and only the flame thereof admitted into the kilns to calcine the lime. In this mode, the coals used are large and of the dearest kind; more of them are required, as they do not act with so much effect; constant attendance is required night and day during the calcination; the kilns are more costly in construction and maintenance, and much expensive iron work is required.

"If we calcine some limestone in an iron tube, or retort, set in a brick furnace, and then allow the retort to cool very slowly, while another portion of limestone is being calcined in a similar retort which is connected by an iron tube with the first, so that the carbonic acid gas may be conducted into the first retort, it will be there absorbed by the hot lime, which thus becomes uncalcined as it were, and is recarbonated more or less according to the care taken in conducting the experiment.

"If we now inquire why the first mode is so uncertain, we shall find that the kilns are commonly constructed about equal in diameter and depth, and that the most careful workmen find it difficult, or impracticable, to draw the calcined lime, so that portions of it do not intermix with portions of the uncalcined and of the fuel. In which case, a portion of uncalcined lime escapes calcination, and a portion of that which is calcined becomes more or less uncalcined, and a very irregular article is thus produced.

"If lime kilns were always constructed of two or three diameters in depth, careful workmen might always draw without intermixing the calcined and uncalcined strata in the kilns, and a good article would always be produced at the least expense of time and trouble, and that this mode will succeed in practice with any description of limestone, will be apparent, when we state that the most difficult carbonates to calcine, are those employed in the production of cements, which must be sufficiently calcined to become tender for grinding, while from their chemical qualities they are easily fusible with a small excess of fuel; now as these carbonates are well calcined in such kilns, it must be evident that all may be so, as no others can from their nature be so difficult to manage.

"In either of the two modes of calcination the lime is allowed to cool in contact with atmospheric air, and this we have already seen is essential to the production of lime. For, if having calcined lime in a reverberatory furnace, wherein coke has been used for fuel, and if then a fresh supply of fuel be added, and the supply of fresh air prevented to the furnace and to the chimney, by closing the apertures thereto, and the lime be thus allowed to cool, it will absorb and condense much sulphuretted hydrogen as well as carbonic acid gas, and when cool, will be incapable of slacking with water, and if pulverised and tempered with water, it will set as cement, for a long time thereafter, exhaling the peculiar odour of sulphuretted hydrogen.

"If, when the lime is about to be thus cooled in a reverberatory furnace, a portion of pine wood is added to the other fuel, the lime when cool will be found nearly black throughout its whole substance by the vapour of carbon which has penetrated and been condensed therein; a black cement has been thus obtained, coloured probably, as some black marbles are found by analysis to be: the Kilkenny or black Irish marble, owing its colour to its containing two per cent. more carbon than white marble, which always holds twelve per cent. combined with oxygen in its carbonic acid, and Kilkenny marble holds only two per cent. more, but being uncombined, it acts as colouring matter, showing what a great difference in sensible qualities is made by a small difference in the quantities and chemical arrangement of the elements of solid bodies.

"Every different species of carbonate requires a different quantity of fuel for its due calcination, the argillaceous varieties requiring a quantity very nearly proportioned to the carbonic acid in them; hence, the inference is, that the heat evolved is essentially employed in converting the acid into permanent gas. Thus, two measures of small Newcastle coals are required for the calcination of ten measures of Thames chalk, and is sufficient for fifteen measures of Roman cement stone; but as this latter substance is about one third ferruginous and argillaceous matter, it would seem to require the expenditure of little fuel for that portion. As a measure of chalk is about twice as heavy as a measure of coals, it follows that, ten pounds of coals are required to calcine 100 of carbonate, or one pound coals to 4.4 pounds carbonic acid; but as eighty-four pounds of the live coals would heat and evaporate twelve cubic feet of water, one pound of coals would heat and evaporate nine pounds of water. We thus find by rather a rough process, but from facts correct enough for general reasoning, because derived from operations conducted on the large scale, that the latent heat in carbonic acid gas is about double the latent heat of steam.

"If thirty-seven parts hydrate of lime is placed in contact with twenty-two carbonic acid, the nine parts of water in the hydrate will be all expelled, and the carbonic gas combining in a solid form with the lime gives out its latent heat, which being taken up by the water, it escapes in the form of vapour, or steam of superior elasticity to the atmospheric pressure, although its temperature is insensible: this very curious or rather wonderful fact, and others, hitherto, I believe, wholly unnoticed, we shall see amply verified when we examine the properties of cements."

In the number for September we find, under the head of Physical Science, a very interesting history of the early experiments on atmospheric electricity, being a report presented by a committee of the *Franklin Kite Club*, and drawn up at the request of the club—which, we presume, is a society formed for the prosecution of electrical researches. The great and increasing importance of this branch of natural philosophy, and the close connexion established between it and many of the most singular and, till lately, most obscure classes of natural phenomena, induce us to extract entire this account of its early progress, which has evidently been drawn up with considerable care and attention :—

"The Committee appointed to inquire into the history of experiments, upon the electricity of the atmosphere; having given such attention to the subject as their other engagements would allow, beg leave to submit the following report:

"The fact that amber and some gems, when excited by friction, possessed the curious property of attracting light bodies; was known to philosophers several centuries before the Christian era. Nothing further, however, than this simple fact, seems to have been ascertained for the space of two thousand years.

"The first modern experiments upon record were those of Dr. Gilbert of Colchester, an account of which he published about the year 1600, in a treatise *de magnete*. Although several philosophers repeated the experiments of Gilbert, and somewhat augmented the list of electric substances, no discovery of importance was effected until about the year 1670, at which period Otto Guericke, celebrated as the inventor of the air-pump, constructed the first electrical machine of which we have any account, and acquired an additional title to renown, by discovering the light and sound by which the electric fluid is accompanied.

"The existence of electric light was observed shortly afterwards in England, by Dr. Wall, to whom also is due the honour of first suggesting the idea of a resemblance between electricity and lightning.

"This resemblance was afterwards noticed by Mr. Stephen Gray, who flourished about the year 1730; and still later by the Abbé Nollet: but neither of them appears to have attempted any investigation of the subject. The complete solution of this interesting problem in electrical science was reserved for our venerated countryman, Franklin; who at an early period of his investigations, became strongly impressed with the idea that lightning and electricity were identical. He accordingly drew up a statement of the principal points of resemblance between them, and suggested a plan for proving the truth of his theory, by elevating pointed conductors upon a lofty tower or spire. This paper, together with several others upon the same subject, he transmitted to his friend Mr. Collinson, of London, by whom they were communicated to the Royal Society.

"The reception which these essays met with in that learned body was by no means flattering, as will be perceived from the following extract from Franklin's Memoirs. 'Obliged as we were to Mr. Collinson, for the present of the tube, &c., I thought it right he should be informed of our success in using it, and wrote him several letters containing accounts of our experiments. He got them read in the Royal Society, where they were not at first thought worthy of so much notice as to be printed among their transactions. One paper which I wrote for Mr. Kinnersley, on the sameness of lightning and electricity, was read, but was laughed at by the connoisseurs.' The papers being afterwards shown to Dr. Fothergill, he thought them of too much importance to be stifled, and advised the printing of them. They were accordingly published in a pamphlet form by Cave, a bookseller in London, with a preface by Dr. Fothergill. A copy of this pamphlet happening to fall into the hands of Buffon the naturalist, this eminent philosopher was so well satisfied of the justness of Franklin's views, that he determined on making the attempt to draw down lightning from the clouds. Accordingly, he raised an insulated rod of iron upon the tower of Montbar, and prevailed upon M. D'Alibard to prepare an apparatus for the same purpose at Marly La Ville, about six miles from Paris. This apparatus consisted of a pointed iron rod, about forty feet long and an inch in diameter, the lower extremity of which was brought into a sentry box and insulated upon a table with glass feet. M. D'Alibard entrusted the charge of his apparatus to a man named Coiffier, who having served fourteen years in the dragoons, was supposed to have sufficient courage for such an undertaking.

"We have been thus particular in our description of this machine, because it was the first to receive a visit from the ethereal fire; and shall now proceed to give a narrative of that important event, extracted from a paper laid before the Royal Academy of Science, at Paris, three days after the occurrence. 'On Wednesday, the 10th of May, 1752, between two and three o'clock in the afternoon, M. Coiffier, an old dragoon, whom I had entrusted to make observations in my absence, hearing a pretty loud clap of thunder immediately flies to the machine, taking with him a vial in which was fixed a brass wire; on presenting the point of the wire to the rod he sees a small brilliant spark issue from it, and hears a crackling noise; he takes a second spark stronger than the first and with a louder noise! He calls his neighbours and sends for M. Raulet, the Prior of Marly. The Prior runs with all his might, and the parishioners seeing his haste imagine that poor Coiffier had been killed by the thunder; the alarm spread throughout the village, and the hail which succeeded did not prevent them from following their Pastor.

"'The honest ecclesiastic arrived at the machine, and seeing there was no danger, tries the experiment himself, and takes some strong sparks. The hailstorm was not more than a quarter of an hour in passing the zenith of our machine, and there was no more thunder after the first clap.' As soon as the cloud had passed, and they could get no more sparks from the rod, the Prior despatched M. Coiffier with the following hasty letter :—

"'I announce to you, sir, the fulfilment of your expectations; the experiment is complete. This day, at twenty minutes after two in the afternoon, it thundered directly over Marly, the clap was pretty loud. The desire to please you, and curiosity, induced me at once to quit my arm-chair, in which I was engaged reading. I was hastening to M. Coiffier, and met on the road a child whom he had despatched to call me, I redoubled my speed through a torrent of hail. Arriving at the spot where the rod was placed, I took a brass wire and advancing it towards the rod, when within about an inch and a half, a small column of bluish flame with a smell like sulphur, sprung with wonderful quickness to the point of the wire, and occasioned a noise as if the rod had been struck with a key. I repeated the experiment at least six times in about five minutes, each experiment requiring about the time of a Pater and an Ave. I wished to continue them, but the action of the fire gradually abated, and at length ceased altogether. The stroke of thunder which had occasioned this event was not followed by any other, and the whole was terminated by a copious shower of hail.

"'I was so engaged during the experiment, that receiving a blow upon my arm above the elbow, I could not tell whether it proceeded from the brass wire or the rod. I did not complain at the moment, but the pain continuing on returning home, I uncovered my arm in the presence of Coiffier, and we perceived a contusion around it, such as would be caused by a blow from the wire upon the bare skin. When returning with Coiffier, I met the curate, M. de Milley, and the schoolmaster, to whom I reported what had happened. They all three perceived a smell of sulphur, which increased as they approached me: this odour was also perceived by the servants before I said any thing to them about it.

"'You have here, sir, a hasty recital, but it is correct and true, and I assure you that I am prepared to testify to these facts on all occasions. Coiffier was the first to make the experiment, and he repeated it several times before he sent for me. If any other testimony besides his and mine is necessary you can obtain it. Coiffier is in haste to depart. I am yours with respectful consideration, Raulet, *Prior of Marly*.'

'*May* 10, 1753.'

"Immediately upon the announcement of M. D'Alibard's success, M. Delor, demonstrator of physic, at Paris, erected a bar of iron upon his dwelling for the purpose of repeating the experiment, and succeeded in procuring several sparks during a thunder-storm on the 18th day of May. On the 19th of the same month, Buffon obtained a similar result at Montbar.

"Thus was Franklin's hypothesis verified in Europe, while its illustrious author was awaiting for the erection of a spire at Philadelphia, by which he should be enabled to reach what he supposed to be the proper region for experiment. At length he devised the simple expedient of using a common kite for the attainment of his object, and in June, 1752, about a month after the French discoveries, but before any report of them had reached America, he performed his celebrated experiment.

"Although it may seem unnecessary to repeat in this place a narrative with which every schoolboy is familiar, we shall, nevertheless, annex an account of this famous experiment, believing the omission would leave our report defective in a very essential point. The kite used by Franklin on this occasion, was made by extending a silk handkerchief upon two crossed sticks. To the upright stick was affixed an iron point.

"The string was of hemp, except a small portion of the lower end, which was of silk; where the hempen string terminated a key was fastened. With this apparatus, on the approach of a thunder-storm, he repaired to an open field, accompanied by his son, to whom alone he had communicated his intention.

"Having raised his kite, he placed himself under a shed, to avoid the rain, and preserve the insulation of his silk cord. A thunder cloud passed over the kite, and no sign of electricity appeared. When, almost despairing of success, he observed the loose fibres of the string become erect, as if they were repelled. He now presented his knuckle to the key and received a strong spark; others succeeded even before the string was wet; but when the string was thoroughly wetted by the rain, he collected the electric fire in great abundance.

"Franklin afterwards erected an insulated rod upon his house, by means of which he continued to investigate the subject for several years, in conjunction with his friend Mr. Kinnersley. The new field of discovery thus opened to the votaries of science, was speedily entered by a host of experimenters. Of these, it will be necessary to name only a few of the more prominent, whose experiments and discoveries embrace all that it is interesting to know.

"In England, the first attempts to repeat these experiments, were made by Mr. Canton and Dr. Bevis; but owing to the unfavourable nature of the climate, or some defect in their apparatus, it was not until after numerous disappointments that they succeeded in obtaining some feeble indication of electricity. The most splendid experiments that have come under the notice of the Committee, were those made in France by M. De Romas, assessor of the Presidial of Nerac. This gentleman made use of a kite which was seven feet five inches in height, and three feet in its greatest width, having above eighteen square feet of surface. The string was wrapped with copper wire somewhat after the manner of the bass string of a violin.

"On the 7th of June, 1753, at one o'clock, it thundered in the west; at half-past two M. De Romas had raised his kite with a cord 780 feet long, inclined at an angle of 45° nearly; so that the elevation of the kite was about

550 feet. To the lower end of the cord he tied a ribbon of silk about three and a half feet long; this was brought under cover of a pent-house, and was there fastened to a heavy stone. Near the junction of the cord and ribbon was suspended a tube of tin one foot long and an inch in diameter, from which the sparks were to be drawn.

"He had prepared a discharging rod with a glass handle twelve inches long, and provided with a brass chain of sufficient length to touch the ground when sparks were drawn from the tube. By means of the discharging rod, he at first obtained sparks as large as those produced by a good globe, and several of his assistants drew sparks with keys and with the naked finger. This performance continued about twenty-two minutes, when the electricity disappeared; the little black clouds from which it was procured having passed from the zenith of the kite. In about seven minutes the electricity re-appeared, but was at first very feeble; it gradually increased, and sparks were drawn by the fingers, canes, and swords, of the spectators. M. De Romas now touched the tube with his knuckle, and received a terrible shock, such as he had never experienced from the Leyden vial charged by the best globes. Seven or eight of the bystanders having joined hands received sparks which struck the feet of the fifth person. The storm now approached and increased in violence, not a drop of rain had fallen; but in the zenith of the kite and about 60° around it, there were black clouds, which indicated a great increase of electricity.

"M. De Romas, therefore, thought proper to receive sparks only by the discharge; and in this manner drew several sparks more than two inches long, and of proportionate thickness. After this, the electricity became so strong, that instead of sparks, sheets of fire three inches long and three lines in diameter, flashed to the distance of more than a foot from the tube. At this time, when about three feet from the cord, he felt a sensation as if a spider's-web was upon his face. He advised his assistants to keep at a greater distance, and himself retired about two feet; and when five feet from the cord, he again perceived the same sensation and retired still further. M. De Romas now paused to observe what took place in the clouds above the kite; there was no lightning, almost no thunder, and not any rain, the wind was west, and so strong that the kite rose about 100 feet higher than at first. Having cast his eyes upon the tin tube which was about three feet from the ground, he observed three straws about a foot long, and others four or five inches in length, standing erect upon the ground, and dancing in a ring beneath the tube like puppets. This little spectacle lasted about fifteen minutes, after which some drops of rain fell, and he again felt the spider-web sensation, and heard a rustling noise like the sound of a small forge bellows. This was considered a warning of a new increase of electricity, and he cautioned his assistants to retire to a greater distance. Now came the last act of this magnificent drama, which M. De Romas says made him tremble. The longest straw was attracted by the tube, and then followed an explosion which some compared to the noise of a petard, and others to the sound of a large earthen jar dashed upon a pavement. The fire which accompanied this explosion had the form of a spindle eight inches long and four or five lines in diameter. The straw which had caused the explosion followed the string of the kite, and was seen at the distance of forty or fifty toises going with great rapidity, alternately attracted and repelled, every attraction being accompanied by sheets of fire and continual explosions.

"During this part of the exhibition there was a strong smell of sulphur, and around the string there appeared a cylinder of permanent light three or four inches in diameter; which, it was supposed, would have appeared to be four or five feet in diameter if the experiment had been made at night. Shortly after this the wind shifted to the east, and the rain fell abundantly, followed by some hail, so that they were unable to keep the kite up any longer; as it fell the string came in contact with a roof; the kite was made to rise again, and as soon as it was released from the roof, the person who held the string received such a violent blow in his hands that he was compelled to relinquish it. The string now became slack, and falling upon the feet of one of the assistants, he felt a concussion almost insupportable. On the 16th of August, 1757, M. De Romas, having again raised his kite with a cord more than 1000 feet in length, obtained results even more astonishing than those just narrated.

"In a letter to the Abbé Nollet, giving an account of this experiment, he says, 'Imagine to yourself sheets of fire nine or ten feet in length, and one inch in diameter, with a noise like the report of a pistol: in less than an hour I had certainly thirty flashes of these dimensions, without counting a thousand others of seven feet and under.'

"The dangerous nature of these experiments was fearfully illustrated about this time, by an accident which created a deep sensation throughout the scientific world. Prof. Richman, of St. Petersburgh, being engaged in a treatise upon electricity, had erected upon his house an apparatus for observing the electrical condition of the atmosphere, during thunder-storms. On the 6th of August, 1753, while attending the usual meeting of the Imperial Academy of Sciences, a little before noon he heard the sound of distant thunder, and hastened home, accompanied by Mr. Sokolow, engraver to the Academy. Upon examining the electrometer which was attached to his apparatus, Richman remarked that the thread pointed to four degrees on the quadrant; and described to Mr. Sokolow the dangerous consequences that might ensue if the electricity should increase to 45° or more. At this moment while Mr. Richman was in a stooping posture with his head about a foot distant from the rod, a globe of white and blue fire about the size of a man's fist appeared between the machine and Mr. Richman's head.

"At the same time a sort of steam or vapour arose which stupified the engraver and made him sink down, so that he could not remember to have heard the thunder, which was very loud.

"As soon as Mrs. Richman heard the loud clap of thunder she hastened to her husband's chamber, fearful of some bad consequences, and found him entirely lifeless, sitting upon a chest which happened to be placed behind him, and leaning against the wall.

"After this unfortunate occurrence, electricians became more circumspect in experimenting upon an agent so dangerous and intractable. The phenomena of thunder-storms having been investigated to a considerable extent, philosophers next directed their attention to observations upon the ordinary electrical condition of the atmosphere and the changes to which it is subject. Experiments of this kind were prosecuted in America by Mr. Kennersley, the friend and associate of Franklin; in France by M. Le Monnier and the Abbé Mazeas; in Switzerland by M. De Saussure; and in England by Mr. Cavallo, Mr. Read, and several others. But the labours of these philosophers, although of great value and interest, fall very far short of those achieved by Signior Beccaria, of Turin, who continued a series of accurate experiments through a period of twenty years.

"The observations of this eminent philosopher were made in all kinds of weather, and every season of the year. He made use of a great variety of instruments, and employed numerous assistants, sometimes causing simultaneous observations to be made at several distant places. As the limits of this report will not allow a detailed account of the phenomena observed by all these philosophers, it is deemed advisable to furnish a condensed statement of the general results, upon which most of the observers agree in a very satisfactory manner.

"In calm, clear, dry weather, the electricity was always perceptible and invariably positive. It was more abundant in winter than in summer. During a rain it was generally negative, but it sometimes became positive while the rain was falling; and on some occasions these changes occurred several times in the course of a single storm.

"In cloudy, damp, or windy weather, it was mostly positive, but feeble. The quantity always increased with the length and elevation of the conductor; insulated strings extended horizontally, sometimes gave strong indications of electricity; a cord 1500 Paris feet in length, extended across the river Po, was found to be as strongly electrified during a shower unattended by thunder, as a rod of metal had been during a thunder-storm.

"The latest of these experiments were made about the year 1791; since which period the interesting phenomena brought to light by the discovery of galvanism, have so much engrossed the attention of philosophers, that the other branches of electrical science have been comparatively neglected.

"As far as the committee have been able to extend their researches, it appears that the observers of atmospheric electricity have confined their experiments to a region of comparatively very small elevation, none of them having attained a greater distance from the surface of the earth than 1000 feet; and even the few who reached this height, made use of such imperfect conductors, as were not calculated to furnish accurate results. It therefore seems probable, that a course of experiments made with good conductors elevated to the height of 10,000 or 15,000 feet, would furnish such an addition to our knowledge of this interesting subject, as would fully compensate the labour and expense necessary for their prosecution."

We observe a short note from our countryman, Mr. R. C. Taylor, "on the Occurrence of Bituminous Coal near the city of Havana, Cuba." The existence of workable coal within the tropics, and in maritime situations, is a subject of great interest, not only to our trans-Atlantic friends, but to the merchants and capitalists of this country, as being intimately connected with the magnificent project of steam navigation between Europe and America; and we are glad to find the well-known geological talents of Mr. Taylor (long an able contributor to the "Philosophical Magazine") employed in researches of a nature so valuable and important. We extract the note in question, as, although very brief, it contains the only notice of the subject yet made public:—

"I observe with much interest the notice of your correspondent, in the last number of the Journal of the Franklin Institute (p. 375) of a plan for extensively working the beds of bituminous coal in Illinois. There is little doubt but that an abundant supply of coal, of the quality he describes, will be of great public utility in the South,—will supersede, for many purposes, the employment of other fuel; and will have a widely-extended market, even down to New Orleans, to the great private advantage also, I trust, of those who are preparing to put this undertaking in execution.

"I do not think, however, that the Illinois coal will form a large article of export, to the Havana for instance, as your correspondent suggests. *The existence of extensive veins of coal within the tropics is now established.* Probably, it is not yet generally known, that there have been recent discoveries of coal of very extraordinary quality, at at least two points on the coast of Cuba, near the Havana. One of these is only three leagues from that city, and two miles from the sea at a place of embarkation. This mine has very recently been investigated by Mr. Clemson and myself, and forms the subject of a joint report to the proprietors, on the quality, quantity, and mode of working it efficiently.

"I do not enter into a description of this singular coal, because we are preparing a separate communication for a scientific institution.

"It is extremely probable that this coal, which contains so remarkable a proportion of bitumen, will be exported from the Havana to most of the ports on the southern extremity of this continent.

"I may add that coal occurs near the north-east end of Jamaica. Mr. De la Beche informs me, however, that these coal-seams are very thin, and that none of sufficient magnitude to render them worth working have been discovered."

Concise Decimal Tables for facilitating Arithmetical Calculations, &c., designed for Practical Men. By TIMOTHY CLAXTON, Boston. Published by the author.

[We copy the following notice from the "Journal of the Franklin Institute." The work appears to be of a very useful nature, and therefore deserves to be made known in this country, notwithstanding we already possess several excellent publications on similar subjects.—ED. M. J.]

A sheet containing one of the most concise series of tables which we have ever seen, for facilitating arithmetical operations, has been published by the author, Mr. T. Claxton, of Boston. It is accompanied by a pamphlet explanatory of the tables, and containing also an exposition of the system of decimal fractions, a list of data from which the tables are compiled, and an index to them.

The tables may be classed as mathematical, mechanical, and miscellaneous. The former contain tables for finding the circumferences and areas of circles from their diameters, the diameters from the circumferences, and square roots of the areas, the side of a square equal in area to a circle from the diameter or circumference given, &c., the solidity of a cone from the square of the diameter of its base, and its height, and a sphere from its diameter, &c. &c. Among the mechanical tables are a series for the reduction of weights and measures, for calculating the weights of solid and hollow cylinders of cast-iron, the weight of square and round bars of iron, of spheres of cast-iron, lead, &c., all from convenient data. Among the miscellaneous tables, are those for reducing sterling money to dollars, or *vice-versâ*, the amount of rent or salary for any number of days, having the annual amount, &c. &c. There are in all forty-eight tables, conveniently arranged upon a sheet of ten by thirteen inches, which may be hung up in the counting-house or folded for the pocket for reference. These tables recommend themselves highly for convenience, and as far as we have examined the calculations we have found them correct.

MACHINERY AND ITS RESULTS.

DEFINITIONS OF A MACHINE AND AN INSTRUMENT.

[*From the Glasgow Liberator.*]

"Machinery is that combination of materials, by the order and adjustment of which, a motion impressed by any power becomes resolved into one or more new motions, as shall be predetermined by the inventor or fabricator of the machine."

The working of a machine is thus in a great degree independent of skill on the part of an operator, the good working of it chiefly depending upon the application of a steady and uniform power. Powers, therefore, which are derived from inanimate nature, are preferred to the power derived from animated beings, not only on account of their superior cheapness, but also on account of their greater steadiness. Thus, the fall of water is, perhaps, of all powers, that which is most esteemed.

"An instrument is a piece of matter used to aid the labour of man, but which receives the direction of its motions, not from the inventor or fabricator, but from the individual whose power is applied to it."

It is by means of machinery that man is enabled to operate upon matter with the greatest facility and precision of execution. By machinery, the skill of the inventor or fabricator may supersede the skill of thousands of operators using instruments, but without machinery. In the invention of machines man exercises what may be called a creating power, and in doing so he puts forth some of the higher powers of his nature, and advances his kind in the scale of intelligence. A question, however, has often been raised, viz. To what extent does machinery confer a benefit upon mankind? and may it not be carried to an injurious extent? It must, in the first place, be admitted that there can be no introduction or invention of new machines, without injury being occasioned to certain individuals, or even to certain classes; for it is very easy to see, and cannot be denied, that workmen who, by long experience, have acquired great skill for particular kind of handicraft employment, must, if their crafts be superseded by machines, be deprived of the peculiar advantages they possessed in their skill, and this, to many, in the decline of life, when they can have but little aptitude to take up a new vocation. It is not, however, the artisan who wholly suffers under such circumstances. The master manufacturer often also sustains a loss; his capital is often employed in the production of an article which becomes superseded by some new invention or discovery, for the production of which his premises and utensils, or his locality, are quite unsuitable. Yet these are but transient evils, and exist not beyond the lives of the individuals primarily affected; whilst the benefits to be derived from the new inventions, are handed down to succeeding generations, and are, even from the first, partaken of by the bulk of the community.

If the question could be tried by the analogy of a single family, united by virtuous and kindred affections and dispositions, then, as such a family could not become too skilful nor too much relieved from the drudgeries of life, so as to enable them more fully to embrace the more elevating pursuits of life, then the question would at once be answered; and as the single family could not possess too great relief from the lower pursuits of life, neither could a nation, being an aggregate of such families. But the question must be argued in another way, and upon arguments not resting upon such analogy.

Let us then inquire, upon simple economical grounds, in the first place, what effect the improvements in machinery would have upon our relations with foreign countries? and let us divide this question, and inquire if there would be any difference of effect as to those countries wherein the wages of labour was cheaper, from those in which the rate of labour might be dearer, than in England? The proportion is easily solved. All those countries wherein the price of labour is cheaper, have in that respect an advantage over England; but, by the improvement of machinery, fewer labourers are required, and thus the disadvantage of a high rate of wages is lessened. In the commercial relations, however, of England with America, in which latter country the rate of wages is higher than in England, the effect must be the reverse of the first case; and the improvement of machinery, by reducing the number of hands required, must lessen the disadvantage in which America is placed in this respect.

Let us now turn and view the question as one of wholly domestic relations; and the more clearly to enable us to do this, let us put out of view foreign relations, and let us suppose the nation made up of the following classes:—

1st, The labourers employed in agriculture. This class, besides the labourer engaged upon the soil, comprehends those who are employed in the manufacture of agricultural implements, so far as they shall be so engaged.

2d, The capitalists who under the name of farmers are the immediate employers of the agicultural labourers.

3d, The proprietors of the soil.

4th, The capitalists who are owners of every other kind of property usually let out for hire. This class comprehends the proprietors of houses, manufactures, machinery, shipping, &c.

5th, The artisans employed in manufactures of all kinds for supplying the wants and comforts of the nation at large.

6th, Merchants of all kinds, who are the agents by which are made in society the exchanges of commodities for those equivalents.

7th, All public and private instructors in religion, morality, the sciences, and the arts.

8th, All those employed in the service of the state, including the army, the navy, and the civil service.

9th, All money capitalists, or capitalist creditors to whom part of the nation is indebted as individuals—the creditors having given trust, upon the presumption that the debtor was possessed of sufficient property to be answerable for payment of the debt when it might be required, may in this way be considered merely as mortgagees over real capital.

10th, All capitalist creditors to whom the nation may be indebted in a collective sense, and who being thus the creditors of the nation at large, may be considered as mortgagees over the general capital of the country. The rights of this class indeed go beyond their right as mortgagees, and they claim a right over future industry.

11th, All the dependent members of the families of the foregoing classes who are unable to provide for themselves. These attach themselves respectively to the several classes of their parents.

12th, All those as servants who minister to the comfort and luxury of others.

13th, All objects of charity.

Of these classes it is to be observed, that there are some, the individuals of which have no necessary duties attached to them, or at least only to a very small extent. Such are, in the first place, the landholders and owners of property let out for hire, they have no indispensable duty beyond receiving their rents and settling with their tenants, and even these duties are frequently performed by deputies under the appellation of agents or factors. Another class, the money capitalist, or capitalist creditors, have scarcely any indispensable duty beyond receiving their annual interest upon their debts. From these classes a new one may be derived the "fruges consumere nati." But assuredly the whole of those classes which are without indispensable duties, do not belong to the derivative class—for to a great extent they voluntarily take upon themselves very important public duties. The two Houses of Parliament are chiefly composed of them, and they to a great extent devote themselves to moral and scientific pursuits, and the high and lofty views of many, which shed, indeed, a lustre upon human nature, greatly transcend those who are forced to pursue the drudgeries of life, whilst both are, as they ought to be, of essential utility to each other. So that, if the virtues of these two classes shall prevail over their vices, it must follow that the greater part of the population which could be relieved, either wholly or in part, from the necessity of labour, by the improvements in machinery, so much better would it be for the community at large. There would be so many more minds, in whole or in part, which would be dedicated to the advancement of themselves and of their fellow men, as moral beings. But this condition of things may obtain, or the reverse may do so. The treasure acquired from the growing wealth of a country has often, as may be read in the history of nations, been the precursor of their fall—the minds of men have become so softened and diluted with luxury, that they have ceased to be capable of vigorous and manly exertion, and the nation has sunk overwhelmed by indolence and voluptuousness.

We are, however, arguing the case upon a ground which the political economist will not admit of. The view which he will take, and the question he will put, will be, whether, by an unlimited extent of improvement in machinery, the advantages resulting will be partaken of proportionally by all classes? or whether, being carried to excess, the advantage resulting will not be wholly to one class, the rich, even to the impoverishing of the working classes?

In considering the question as now put, it is necessary to observe, that the source of all wealth, the result of accumulated labour, is, undoubtedly, an abundance of good and wholesome food, produced by the labour of a limited portion of the population. This being produced and gathered by means of the agricultural labourers, their sustenance and support, or what is called their wages, requires that a certain portion of the produce shall be set aside for this purpose, the remainder remaining with the farmer, who, after retaining a certain amount to repay his necessary expenditure, and as a return for his own skill and labour, and for the capital he has advanced, hands over to the landlord the remainder, who distributes this remainder in procuring necessaries for his family, in their instruction, in payments to his private creditors, and in payments to the tax-gatherers, either for behoof of the national creditor, or for the other purposes of the state.

Such, then, appears to be the order of distribution; first, the labourer has a command over a certain portion; then the farmer and the landlord: each class, and each individual, then, is rich, according to the power he or they may possess of directing the greater portion of the fruits of the soil to channels tending to the gratification of their particular wants.

An improvement in machinery, obviously, cannot lessen the amount of good to be raised from the cultivation of the soil: there will then continue to be the same amount for distribution as before, and this amount must be distributed by the possessor, otherwise to him it must be lost: his own animal wants are limited to but a small modicum; beyond that, whatever he does not distribute for equivalent labour must then be to him lost. The individual interests and passions of mankind, however, ensure that there shall be a complete distribution of food for employment, and thus the power of distribution is quickly passed and diffused through all ranks of society.

Let us now trace the effects of improved machinery, by which certain kinds of manufactures are rendered cheaper, upon the order of distribution—the cheapening of the manufacture being an expression the same as the employing of a fewer hands for a given quantity. Seeing, then, that these manufactures are cheaper, those in whom the power of distribution is vested, require to distribute, for what they may require of these cheapened manufactures, a less quantity than formerly was required; they have, therefore, on hand, a greater remaining power of distribution, which they must do through other channels, that is, other kinds of employment; for, did they not do so of themselves directly, or indirectly by lending their power to others, they would sustain the loss. Such a case practically never occurs, for the wants of the human being are so various and illimitable, that no sooner is one want supplied, than another is sure to spring up. These wants mark the destiny of man; they are not merely animal and sensual, but they are in a great degree his aspirations for higher moral endowments, and a more eager and anxious seeking for the laws and order of Providence.

To return, however, to the cheapened manufacture: it must be obvious that this cheapening gives the power of supplying new wants to every one possessing the power of distribution; but every individual who earns the smallest trifle beyond what is necessary to supply himself with food, is, in fact, a distributor; and in this way every class of society is included.

It will be very obvious, from what has been stated, that since improvements in machinery extend the power of every individual in supplying his wants, in the like proportion they enable him to discharge or lessen his debt, should he be a debtor; and, by an extension of the reasoning, they better enable the community to bear the national debt and the amount of taxation. The same reasoning also applies to cheapened agricultural produce, which must be presumed to arise either from improvements in agriculture, or from the cultivation of more fertile soils, or from importation from foreign parts, in exchange for the productions of our machinery.

Again, by the enlargement and improvement of machinery, the public wants become more fully satisfied—a competition arises amongst manufacturers, who now, instead of being sought by customers, have to seek for them—a fall in the rate of profit, and with it a fall in the rate of the interest of money, is the necessary consequence; the effect of this is to cheapen the manufactures to a degree beyond what would be the natural result of the improvement upon the machine. The creditors and the capitalist are in this way put into less advantageous positions; but the advantage which they lose is partaken of by all other classes of the community, and a greater equality of condition must take place, through which a nation ought to become more happy and prosperous.

MANUFACTURES.—The cotton manufacturers in the West of Scotland are exceedingly brisk, it being found hardly possible to execute all the orders received at New Lanark; a mill burned down in 1819 has been rebuilt, and a water-wheel, thirty-six feet in diameter, is making to drive the machinery. All the iron-works are in full operation, and in general the manufacturers of all kinds were never in greater activity.

COMPOUND MINERAL BODIES.—They are naturally found, in some instances, simply aggregated; as, for instance, when gold occurs in limestone, their separation may be effected mechanically by pounding and washing; but when chemically combined, as when silver occurs united with sulphur, we must depend on the labours of the chemist for their separation.

LEAD AND COPPER MINES.—A tolerable idea may be formed in respect to the value of our insular lead and copper mines from the following circumstances,—that a few days ago, at an auctioneer's sale in Liverpool, 1-15th share of the Isle of Man mines was bought in for 3150*l*.—*Manx Liberal.*

TELEGRAPHIC COMMUNICATION.—It is in contemplation, we understand, to establish a system of telegraphic communication, both by day and night, on the great railroads now in formation, more particularly on the London and Birmingham and Grand Junction lines.

STEAM FLOATING BRIDGES.—Mr. Rennie, the eminent engineer and inventor of the steam floating bridges, so successfully established across Hamoaze, Devonport, is engaged by the postmaster-general to survey the new as well as the old passage across the Severn, and to report on the practicability of adopting at one, if not at both of these ferries, his admirable plan of floating bridges.—*Felix Farley.*

INSECTS.—Dr. Imhoff, in a work presented to the Society of Natural History at Bale, has estimated the number of insects now known at 500,000 species—Germany alone containing 14,000.

RAILWAYS.—The boasted enterprise of England must, in the matter of railways, yield to the superior energy of our trans-Atlantic brethren, since, though so many are projected in this country, we have not yet 100 miles completed, while the United States can boast of nearly 2000 miles in actual use. This arises chiefly from the quantity of unoccupied land, but is also greatly assisted by the superior simplicity of their formation, using wood sleepers instead of our costly stone blocks. Cuba is also exerting itself on this subject, forty miles being nearly completed from Havannah to the inland town of Guines. And we hear with pleasure that our own colonies are following, though at a humble distance, a railway of eighteen miles being contemplated in Jamaica, from Kingston to the Angels, through Spanish Town. The intercourse between the latter place and Kingston is immense, and the undertaking is thought likely to be highly profitable.

London: Printed and Published by HENRY ENGLISH, the Proprietor, at his Office, No. 12, Gough-square, Fleet-street, in the city of London: where all Communications and Advertisements are requested to be forwarded post paid.

[*October 22, 18*[illegible]